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Original Article

Measurement of fetal maxillary and mandibular angles for first-trimester prenatal screening among Taiwanese women

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Abstract

Background: Early fetal structure evaluation is crucial. Fetal abnormalities might indicate chromosomal anomalies or abnormal fetal growth. The aim of this study was to establish the appropriate reference range of maxillary and mandibular angles among the Taiwanese population at 11^{+0}–13^{+6} weeks of gestation in normal singleton pregnancy as reference values for prenatal ultrasonographic examinations.
Methods: Fetal ultrasonographic data on maxillary angles and mandibular angles at a gestational age ranging from 11^{+0} weeks to 13^{+6} weeks were recorded in this study. Maternal background and pregnancy outcome were obtained from hospital records.
Results: A total of 87 patients were included in this study. Maxillary and mandibular angles were successfully recorded in 87 (100%) and 84 (96.6%) patients, respectively. The mean maternal age was 31 (range, 19–41) years, with a corresponding gestational age of 12^{+4} (range, 11^{+0}–13^{+6}) weeks. The maxillary and mandibular angles were 79.9° ± 15.6° and 71.0° ± 12.8°, respectively. First-degree correlation was not found to exist between gestational age and maxillary and mandibular angles.
Conclusion: Normative data for ultrasonographic measurements of maxillary and mandibular angles among the Taiwanese population are presented. Our results may serve as reference values in congenital anomaly screening during prenatal examination.

Keywords: fetal ultrasound; mandibular angle; maxillary angle; prenatal screening

1. Introduction

It is understood that effective screening for major chromosomal abnormalities can be provided in the first trimester of pregnancy.[1] A combination of early biochemical screening tests and specific ultrasound markers, such as nuchal translucency (NT), nasal bones, abnormal flow in the ductus venosus, and abnormal tricuspid flow, in addition to the frontomaxillary angle and maxillary and mandibular bone lengths, are useful for early diagnosis of chromosomal abnormalities. Most pregnant women prefer screening in the first rather than in the second trimester for chromosomal abnormalities[1] to make further decisions on whether to continue or terminate the pregnancy. The aim of our study was to establish the appropriate reference range of maxillary and mandibular angles within the Taiwanese population at 11^{+0}–13^{+6} weeks

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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of gestation in normal singleton pregnancy as reference values for prenatal ultrasonographic examinations.

2. Methods

The study population included 87 Taiwanese singleton pregnant women with a gestational age ranging from 11^{+0} weeks to 13^{+6} weeks, who were undergoing NT screening for Down's syndrome at Taipei Veterans General Hospital, Taipei, Taiwan from January 2011 to January 2012. Ultrasonographic examinations were performed transabdominally, using high-resolution ultrasound equipment with three-dimensional (3D) capabilities (transabdominal 4–8-L probe; GE Voluson Expert 730 or GE Voluson E8; GE Medical Systems, Zipf, Austria), to measure the fetal maxillary and mandibular angles. The measurements required 5 additional minutes after finishing the NT screening test. We made a transverse section over the level of maxillary arches. We utilized the three-point angle function to draw a line from one side of the maxilla to the conjoining point on the opposite side of the maxilla. The 3-point angle calibration function (GE Voluson Expert 730 or GE Voluson E8; GE Medical Systems, Zipf, Austria) was utilized to measure maxillary angle. The same method was used to obtain the fetal mandibular angle as well (Fig. 1). Maxillary angles and mandibular angles of infants with gestational age ranging from 11^{+0} weeks to 13^{+6} weeks were recorded in this study. Maternal background and pregnancy outcome were obtained from hospital records. No fetal anomalies, intrauterine fetal death, or fetal growth restriction of neonates were noted. The study was approved by the Institutional Review Board (VGHIRB No. 201002049IC) at Taipei Veterans General Hospital and was conducted with the consent of each participant.

The relationships between the maxillary angle, mandibular angle, and gestational age were evaluated by regression analysis. Pearson's correlation test was used to assess the degree of correlation between variables.

3. Results

A total of 87 singleton pregnant women between 11^{+0} weeks and 13^{+6} weeks of gestation were enrolled in this study. The mean maternal age was 31 (range, 19–41) years, with an average corresponding gestational age of 12^{+4} (range, from 11^{+0} to 13^{+6}) weeks.

The maxillary and mandibular angles were successfully examined in 87 and 84 patients, respectively, and the corresponding angles were 79.9° ± 15.6° and 71.0° ± 12.8°. The success rates for measuring maxillary and mandibular angles were 100% and 96.6%, respectively. The mandibular angles of three patients could not be identified because of poor image quality resulting from inadequate fetal position. Both the maxillary and the mandibular angles were not significantly different between gestational ages, as described earlier ($p = 0.177$ and $p = 0.175$, respectively; Figs. 2 and 3).

4. Discussion

Facial dysmorphism is an important part of the phenotype of many syndromes, including trisomy 18 (Edwards syndrome).[2] Effective first-trimester screening for chromosomal disorders, such as trisomy 21 and trisomy 18, is provided by a combination of maternal age, fetal NT thickness, maternal serum-free beta-human chorionic gonadotropin, and pregnancy-associated plasma protein A.[2–5] Trisomy 18, the second most common chromosomal abnormality after trisomy 21, is associated with early onset growth restriction and multisystem defects that can be detected by prenatal ultrasonography.[2] A common facial feature in trisomy 18 is micrognathia.[6] On a prenatal ultrasound, the diagnosis of micrognathia is a subjective opinion.[2] Therefore, several attempts at providing an objective basis for prenatal diagnosis of micrognathia by two-dimensional ultrasound have been published. Nevertheless, these measurements have not been incorporated into routine screening protocols, and the advent of 3D ultrasound has made it possible to define the

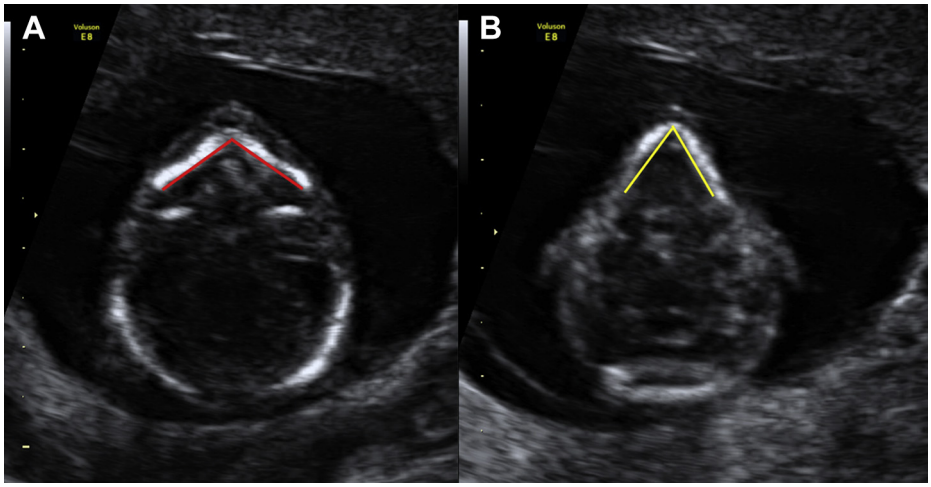

Fig. 1. Measuring the fetal maxillary and mandibular angles: (A) red, maxillary angle; (B) yellow, mandibular angle.

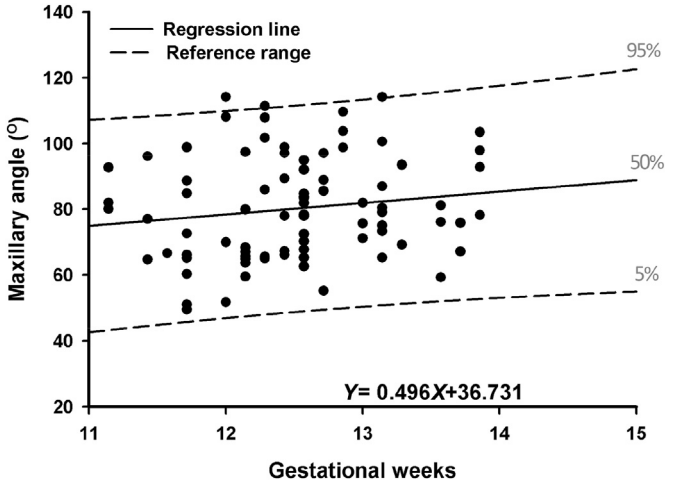

Fig. 2. Reference range of the maxillary angle in chromosomally normal fetuses.

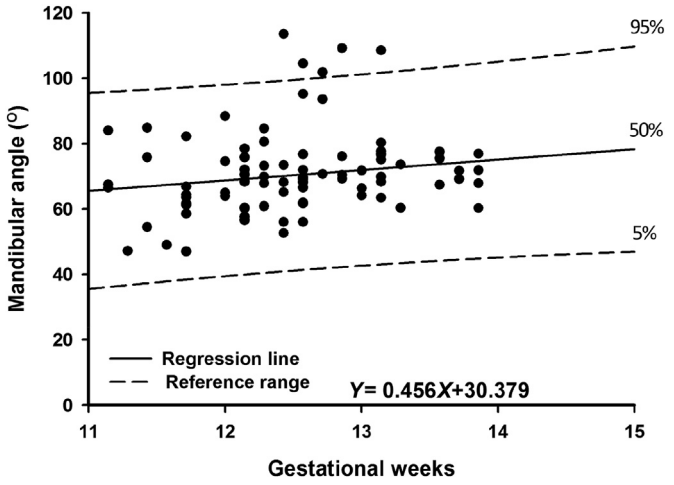

Fig. 3. Reference range of the mandibular angle in chromosomally normal fetuses.

relative position of the mandible compared with other facial bones.[2,6]

Many studies recommend the measurement of the frontomaxillary facial angle and the mandibulomaxillary facial angle for first-trimester screening of fetuses with chromosomal defects.[3,7,8]

The purpose of our study was to establish the additional ultrasonographic markers for first-trimester fetal screening. We measured the maxillary and mandibular angles of singleton fetuses among Taiwanese pregnant women at 11^{+0}–13^{+6} weeks of gestation. Neither the maxillary nor the mandibular angles were observed to be different as gestation progressed. The regression line between the maxillary angles and gestational weeks showed a linear growth pattern (Fig. 2), and an insignificant difference was found between the maxillary angles and the gestational weeks ($p < 0.177$). The results between the mandibular angles and the gestational weeks (Fig. 3) were the same as for the maxillary angles. In anomalous fetuses, these angles are usually below 90° for the period between 14 weeks and 20 weeks of gestation. The pregnancy outcome of our study population showed no chromosomal abnormalities, including trisomy 21 and trisomy 18.

There were some limitations of our study. First, the studied population was not sufficient in size to determine the reference data of both the maxillary angles and the mandibular angles among the Taiwanese population. Second, no chromosomally abnormal fetuses, such as those with trisomy 21 or trisomy 18, were observed in our study population, which made it difficult for us to know whether the presence of a different angle or not is an indication of chromosomal abnormalities or how much difference in the angle would exist between the normal chromosomal groups and the abnormal chromosomal groups. Based on these limitation factors, we are not certain of the potential for using both the maxillary angle and the mandibular angle as first-trimester ultrasonographic markers for prenatal screening.

In conclusion, effective screening for major chromosomal abnormalities can be provided in the first trimester of pregnancy through some biometric tests combined with modern diagnostic tests using ultrasound markers such as NT, nasal bones, abnormal flow in the ductus venosus, and abnormal tricuspid flow.[1,4,5] The addition of the frontomaxillary angle, maxillary and mandibular bone lengths, prefrontal diameter, and 3D ultrasonographic retronasal triangle, emphasizing the evaluation of the nasal bones, are other feasible soft markers for an early diagnosis of chromosomal abnormalities.[2,6,7] Therefore, further studies with a larger number of cases and longer range of gestational age to confirm the results we have presented and establish an accurate reference range for the Taiwanese population are warranted.

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